ACCELERATED SITE TECHNOLOGY DEPLOYMENT PROGRAM

# In Situ Sampling of Trichloroethylene at Test Area North

JUNE • 1998

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

**United States Government** **Department of Energy**

# memorandum

Idaho Operations Office

Date: June 12, 1998

Subject: Submittal of Accelerated Site Technology Deployment Proposal - (LD-98-183)

To: James R. Wade, Director
Accelerated Site Technology Deployment Program
DOE-ID, OPE, MS-1235

In response to the Accelerated Site Technology Deployment (ASTD) call for proposals, dated May 1, 1998, we are pleased to submit the ASTD proposal "In Situ Sampling of Trichloroethylene at Test Area North." This proposal has the full support of both the Office of Laboratory Development and Office of Program Execution at the U.S. Department of Energy Idaho Operations Office (DOE-ID). Implementation of the project described in the proposal will enhance our Environmental Management capabilities and the ability of the Idaho National Engineering and Environmental Laboratory to meet its priority regulatory commitments.

DOE-ID is confident that the Idaho National Engineering and Environmental Laboratory has the ability to implement the technology approach described in the proposal within current funding levels and schedules.

We look forward to working with the ASTD Program and are eager to begin this deployment effort.

Kathleen E. Hain, Director
Environmental Restoration

Jerry L. Lyle, Assistant Manager
Office of Program Execution

Attachment

cc: W. E. Bergholz, MS-1203
A. C. Williams, MS-1103
G. J. Schneider, MS-1219
T. E. Williams, MS-1235
G. L. Smith, MS-1170

# *Executive Summary*

Cleaning up groundwater contaminated with volatile organic compounds is a significant challenge for the Department of Energy and private industry alike. Compounds like trichloroethylene (TCE) leave residual contamination in the aquifer in the path they travel. A very small amount pure TCE, commonly called raw product, can contaminate groundwater beyond regulatory drinking water limits. Since the raw product is not very soluble in water, the majority of the contamination remains in “hard to find” places and the small amounts that become soluble contaminate groundwater above regulatory levels for long periods of time.

A new method for helping determine the paths that contaminants like TCE are traveling through the aquifer has been developed at the Idaho National Engineering and Environmental Laboratory (INEEL). The method involves using a probe in the groundwater called the In Situ Sampler (ISS) to monitor the concentration of TCE at numerous depths down a well. This information will help determine where the contaminants are traveling through the fractured subsurface. This will ultimately aid in helping clean up contaminated sites.

The ISS probes use a permeable membrane, which absorbs volatile organic compounds from the groundwater. Several of these probes will be used to create a depth profile in three groundwater wells located in a contaminated region of the aquifer at the Test Area North (TAN) facility at the INEEL. The process requires very little labor to install the probes. After a period of days samples will be collected from the probes and analyzed on site.

A packer system is the baseline technology that would be used to obtain the same information. The estimate for using a packer system is $150,460 and the estimate for using the ISS method is $79,960 (a detail of all cost estimates is given in the Cost Overview section of the proposal). Using the ISS method instead of the baseline technology creates a cost savings of $70,500. This project will leverage $45,100 from operations and requests $34,860 from Accelerated Site Technology Deployment Program. The Return on Investment for the proposed work is 2.02.

# *Table of Contents*

# Screening Criteria Assessment

| | Screening Criteria | Referenced Page(s) | To Be Filled Out By Selection Committee Only<br>Did Proposal Meet This Criteria? (Yes/No) |
|---|---|---|---|
| 1 | The end-user need, as identified through the Environmental Management (EM) Integration disposition maps and/or outlined in *Accelerating Cleanup: Paths to Closure*. (Needs not identified within these documents must provide clear, concise justification for further evaluation.) | pg 2, par 3 | |
| 2 | A completed cost benefit analysis has been submitted comparing a detailed cost estimate of the proposed technology or process against a validated cost estimate of the baseline technology or process. | pg 6, par 1 | |
| 3 | The proposal is not requesting funds for a demonstration, but for technology deployment. | pg 2, par 6<br>pg 3, par 2 | |
| 4 | Joint funding or in-kind contributions of at least 50% of the project costs are provided by the proposing organizations, including 25% in the first year. | pg 5, par 3<br>pg 5, Table 2 | |
| 5 | The proposal provides a written commitment from the proposing DOE Site Manager, Site Assistant Manager of EM, or equivalent with the budget authority. | memo, pg iii | |

***NOTE:*** *Sidebars placed throughout the text indicate where screening criteria have been met. The number next to the bar references the appropriate criteria.*

# 1.0 Introduction and Background

A new technology, the In Situ Sampler (ISS), for characterizing volatile organic compounds (VOCs) in groundwater has been recently developed and demonstrated at the Idaho National Engineering and Environmental Laboratory (INEEL) and at TSI Inc. The ISS allows the user to determine VOC concentrations in groundwater at any depth in the well. No waste is generated when using the ISS unlike conventional systems that require evacuating three well volumes of groundwater from the well casing before sampling. In addition, there are no water samples to dispose of because the technology utilizes air samples. Determining the concentration gradients along the groundwater wells at the Test Area North (TAN) will help determine how the contaminants are traveling through the saturated zone and ultimately aide in cleaning up the VOC contamination. The conventional way of obtaining this information was by installing a packer system and collecting samples from isolated zones between the packers. The ISS approach can be used at only a fraction of the cost of the packer system and provides greater resolution of the contaminant concentration along the well.

# 2.0 Part I — Technical Proposal Overview

### 2.1 Impact/Technical Approach

Information gained from using this technology will give a better understanding of contaminant transport through the subsurface. This will ultimately aid in cleaning up contaminated sites both onsite and offsite.

William J. Buttner, Ph.D. from TSI Inc. has collaborated with INEEL personnel in the development and field testing of this technology. TSI manufactures and sells gas analyzers. Additional companies like INNOVA and Photovac that sell gas analyzers have also expressed interest in this technology.

A specific end-user technology need as documented by the INEEL Site Technology Coordination Group and outlined in the *Accelerating Cleanup: Paths to Closure* would be supported by this deployment. Specifically, technology need ID-6.1.02, "Real-Time Field
1 Instrumentation for Characterization and Monitoring Soils and Groundwater." This technology need was drafted in November 1996 and is applicable to virtually every environmental restoration Project Baseline Summary (PBS) at the INEEL. The deployment proposed here is specific to PBS ID-ER-101, "Test Area North."

The ISS allows the user to determine the VOC concentration found in a well at any desired depth as shown in Figure 1. The probes can be lowered down a well by hand to the desired depth. The conventional way of obtaining this information is by installing a packer system and pumping out water between the packers. As outlined in the cost section, using the ISS is considerably less expensive.

A patent has been applied for concerning this technology. An application for a Research and Development (R&D) 100 Award has also been submitted.

The ISS was field tested and demonstrated at TAN.
3 The field tests provided depth-profiling data for chlorinated solvents in groundwater.

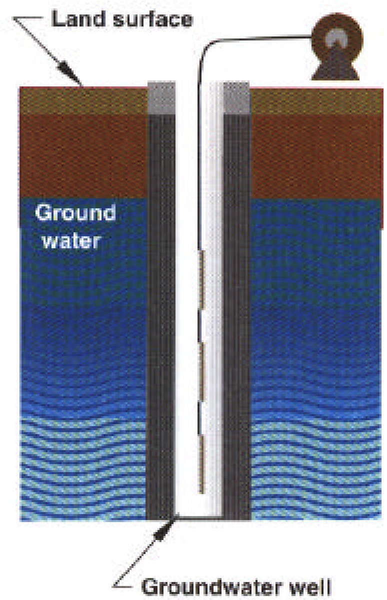


**Figure 1.** ISS lowered into well.

Figure 2 shows a cut-away representation of the ISS in a groundwater well casing. The probe consists of a semipermeable membrane surrounded by a protective PVC covering. When the tubing is immersed in water containing VOCs, the VOCs absorb into the pores of the membrane. After a period of days, the probes can be removed from the well for the collection of an air sample. The VOCs are stripped from the tubing by

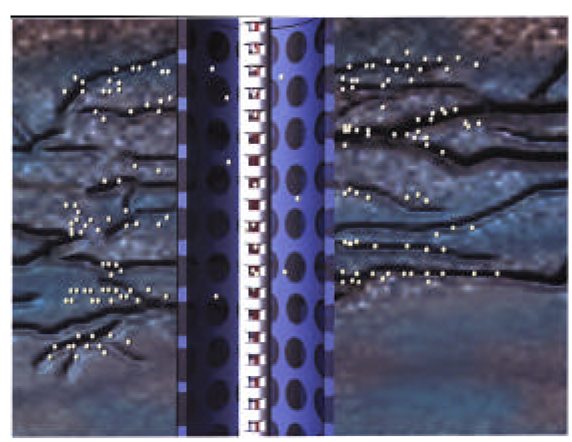

**Figure 2.** Cut-away view of probe in well casing.

passing air through the tubing. Analytical equipment onsite is used to analyze the air samples. In contrast, water samples sent to a laboratory for analysis typically take at least 40 days for the results to be returned. The concentration of VOCs in the air passed through the tubing is proportional to the VOC concentration found in the groundwater. Calibration curves developed in the laboratory show the relationship of the VOC concentration in groundwater to the VOC concentration in the air passed through the membrane.

***Additional Information.*** Cleanup of VOC contaminated groundwater is currently under way at TAN using a pump and treat system. Natural attenuation studies are also taking place to find more effective ways of cleaning up the groundwater at TAN. Determining how VOC concentrations vary along the wells will help in mapping out how the contaminants are traveling through the fractured subsurface. Locating the contaminants and their paths will greatly aid in the cleanup of these contaminants. Typically the groundwater wells have been sampled with a pump which mixes and stirs the water in the well. This provides only an average concentration in the well. There is no way of knowing if much higher concentrations of VOCs are entering the wells through the fractured basalt. The baseline technology is an expensive packer systems that is installed on a temporary basis to isolate specific zones. It is a very expensive process to bring in the large equipment to setup the packers. The ISS requires no large equipment to install, can be used for long-term monitoring, creates no waste in the process, and can be used to monitor in 1-foot intervals where a packer system recently provided an average concentration over a 20-foot interval.

The ISS has been completely tested and was demonstrated in FY-97 at the INEEL. This technology is completely ready for implementation in FY-99. It is
3 proposed to deploy the ISS to create concentration profiles in three TAN wells. Each well will require five deployments to complete the profile. All fieldwork, data interpretation, and final reporting for all three wells will be completed in FY-99.

## 2.2 Business/Management Approach

A written commitment has been obtained from the Department of Energy (DOE) Idaho Operations Office (-ID) Environmental Restoration Operations Director, Kathleen Hain (see page iii).

A detailed schedule for implementing this technology at TAN is attached (Attachment 1). As shown on the schedule, the safety documentation will be prepared and then three wells will be profiled, each well requiring five deployments. Each deployment will take approximately 2 weeks. After the data has been collected, the scientists and project personnel from TAN will be allowed to review the data. When that has been completed, a report including all of the data collected will be completed.

## 2.3 Stakeholder/Regulatory Approach

Three well volumes are normally purged from a well when it is sampled with a submersible pump. At the TAN facility, the groundwater has been declared a listed waste under the Resource Conservation and Recovery Act (RCRA). Under this law, the groundwater has to be treated before it can be disposed. Historically, the water purged from the wells has been delivered and processed at the Groundwater Treatment and Facility at TAN. Under the current negotiations with the State of Idaho, water produced from those wells that was obtained not in support of Operable Unit 1-07B cannot be disposed of in the TAN facility. The proposed approach would eliminate the need to have the groundwater treated. This is because air samples are collected instead of water samples. This also eliminates the need to dispose of the water samples after the analysis has been completed.

The Environmental Protection Agency (EPA) is also encouraging the gathering of depth profile information from groundwater wells. The flow paths in fractured basalt are very complicated. Additional information like this from the TAN wells will help define how the contaminants are being transported. Understanding where and how contaminants are being transported will ultimately aid in cleaning up the groundwater.

The INEEL's stakeholder and regulatory approach ensures that all regulators, stakeholders, and tribes are active participants in the planning and implementation of programs that affect the local community and the larger public affected by DOE Complex-wide issues. DOE-ID and its Management and Operations contractor, Lockheed Martin Idaho Technologies Company (LMITCO), have established a rigorous systems engineering process for public participation that facilitates identification, documentation, and tracking of issues and requirements in conjunction with the stakeholders. This systems engineering process has proven effective for projects and programs similar to implementation of the ISS.

A key element and approach to the INEEL stakeholder program is the Stakeholder Participation Plan. This plan provides a mechanism for stakeholders to be involved in the proposed INEEL technology deployment, to the maximum extent feasible, giving opportunities to impact decision-making throughout the process. The purpose of this stakeholder plan is to guide the process for achieving full and effective stakeholder participation, while at the same time using existing INEEL stakeholder groups to the greatest degree possible.

# 3.0 Part II — Cost Overview

## 3.1 Cost Benefit Analysis

The baseline method required to perform sampling of trichloroethylene (TCE) in the groundwater is a packer system, the life-cycle cost of utilizing this method is summarized in Table 1. In support of the costs summarized in Table 1, a detailed cost estimate is provided as Attachment 2.

The pricing proposal forms shown in Tables 1 and 2 are identical to that required for the previous Technology Deployment Initiative proposals (1997).

These tables summarize the costs associated with the various functions of utilizing the baseline technology and present a breakout of the overhead and other financial costs.

The innovative technology proposed is an ISS that was developed at the INEEL and demonstrated in 1997. The life-cycle cost of utilizing this technology is summarized in Table 2 and a detailed cost estimate is provided as Attachment 3. Table 2 also identifies the amount of leverage or co-funding that will be provided by INEEL Operations, as being $45,100. 4

**Table 1.** Current baseline pricing proposal form.

| *Project Cost Summary (Life Cost Estimates)* | | | | | *Financial Costs* | | |
|---|---|---|---|---|---|---|---|
| | | | | | *Support Costs* | | *Direct Costs* |
| *Activity Cost Element (Work Breakdown Structure System Cost Components)* | *Basis for Estimate* | *Base Cost* | *Overhead Burden Allocation* | *Life-Cycle Cost Estimate* | *General Support* | *Mission Support* | *Operation* |
| 1.0 Initial Activities (Characterization, Design, Assessment) | N/A | 0 | 0 | 0 | | | |
| 2.0 Mobilization Costs | See Att. | 2,040 | 960 | 3,000 | | | |
| 3.0 Production Facility Costs<br>3.1 Setup<br>3.2 Treatment<br>3.3 Demobilization | See Att. | 8,840 | 4,160 | 13,000 | | | |
| 4.0 ES&H and Assurance<br>4.1 Safety Assurance<br>4.2 Permitting<br>4.3 Project Management | See Att. | 4,692 | 2,208 | 6,900 | | | |
| 5.0 Operating and Maintenance Costs | See Att. | 64,300 | 30,260 | 94,560 | | | |
| 6.0 Decontamination and Decommissioning | See Att. | 22,440 | 10,560 | 33,000 | | | |
| **Total Life-Cycle Costs** | — | 102,312 | 48,148 | 150,460 | 9,148 | 12,037 | 26,963 |

**Table 2.** ASTD cost estimate pricing proposal form.

| *Project Cost Summary (Life Cost Estimates)* | | | | | *Financial Costs* | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | *Support Costs* | | *Direct Costs* | |
| *Activity Cost Element (Work Breakdown Structure System Cost Components)* | *Basis for Estimate* | *Base Cost* | *Overhead Burden Allocation* | *Life-Cycle Cost Estimate* | *General Support* | *Mission Support* | *Operation* | *Leverage* |
| 1.0 Initial Activities (Characterization, Design, Assessment) | N/A | 0 | 0 | 0 | | | | 0 |
| 2.0 Mobilization Costs | See Att. | 816 | 384 | 1,200 | | | | 1,200 |
| 3.0 Production Facility Costs<br>3.1 Setup<br>3.2 Treatment<br>3.3 Demobilization | See Att. | 30,260 | 14,240 | 44,500 | | | | 37,000 |
| 4.0 ES&H and Assurance<br>4.1 Safety Assurance<br>4.2 Permitting<br>4.3 Project Management | See Att. | 4,692 | 2,208 | 6,900 | | | | 6,900 |
| 5.0 Operating and Maintenance Costs | See Att. | 18,605 | 8,755 | 27,360 | | | | 0 |
| 6.0 Decontamination and Decommissioning | N/A | 0 | 0 | 0 | | | | 0 |
| **Total Life-Cycle Costs** | — | 54,373 | 25,587 | 79,960 | 4,861 | 6,397 | 14,329 | 45,100 |

4

The amount requested from Accelerated Site Technology Deployment (ASTD) is $34,860, the cost benefit derived by implementing the proposed technology is a 2.02 return on investment (ROI) as shown below. Both the baseline and the proposed technology costs are calculated based on complete project execution in FY-99.

| | | |
|---|---|---|
| 2 | *Baseline Cost (Table 1)* | $150,460 |
| | *Proposed Technology (Table 2)* | $79,960 |
| | *Cost Savings (Baseline – Proposed)* | $70,500 |
| | *Operational Leverage (Table 2)* | $45,100 |
| | *ASTD Request* | $34,860 |
| | *ROI (Savings/Request)* | 2.02 |

## 3.2 Additional Cost Information

The relatively high cost of utilizing the baseline technology is the high amount of labor required to perform the operation. A full-drill rig crew is required to install and move the packers. It would take approximately 43 hours to move the system 10 times to isolate 10 different zones within each well (see Attachment 2). In addition, the baseline technology generates large quantities of wastewater each time the well is purged. The purge water has been declared a listed waste so this water would need to be treated. It is estimated that the purge water could be treated in the evaporator at the Idaho Nuclear Technology and Engineering Center for $10/gallon (see Attachment 1).

Implementation of the ISS requires very little labor. One person can lower the ISS probes into a well and then return on another day to collect and analyze the samples (see Attachment 3). Another significant benefit of implementing the ISS is, unlike the baseline method, it generates zero waste. The elimination of large quantities of wastewater combined with lower labor significantly reduces the cost of sampling TCE in wells.

INEEL base costs include labor, materials, fringe, and facility costs. Overhead burden includes general and administrative and overhead costs. General and administrative rate is 32.5% and overhead rates varies between 11% and 12%, depending on the organization. All rates can be found in the *LMITCO FY-98 Planning Preparation Guidance*, Revision 8, Section 10, "Planning Rate Guidance." Functional costs breakdown are 56% direct and 44% support consistent with the INEEL Paths to Closure.